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U1S S1820

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US 4844493 A US 3856104 A

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RBD32
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(54) Motorized carriers

(57) An automatic motorized golf trolley having control means is arranged to maintain a fixed separation distance between the trolley and the golfer. The trolley is provided with an ultrasonic transmitter 26 and a directional receiver 27, the transmitter being arranged to transmit an identification code which is received by a remote unit attached to the golfer. The remote control unit comprises an ultrasonic receiver which receives transmitted signals, comparison means for comparing a received signal against a stored code, and means for transmitting, via a transmitter mounted on the remote control unit, a carrier control signal for reception by the receiver of the trolley. The control means is arranged to analyze the time separation between transmission of the identification code and reception of the control signal, and the direction from which the control signal was received, and to drive the trolley accordingly. The remote control unit comprises means for delaying the transmission of a control signal in order to eliminate the effect of reflections at the carrier receiver. A clutch and brake mechanism for the trolley comprises an electric motor which drives a worm gear to axially move the clutch. The brake engages at the extreme end of its travel.

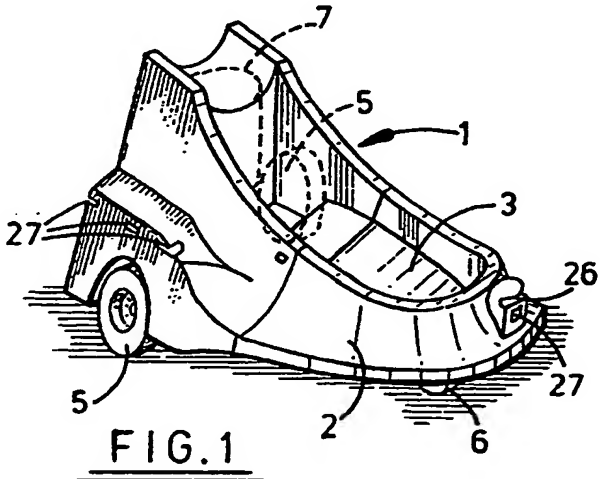

FIG.1

GB 2 283 838 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

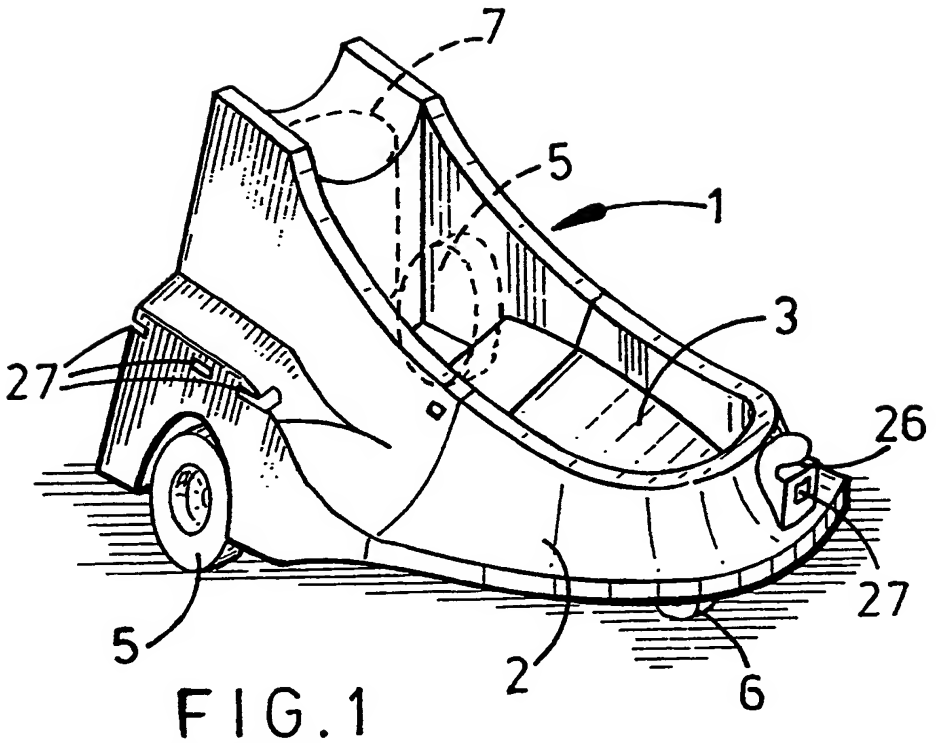
7
5
1
3
27
26
27
5
2
6

FIG.1

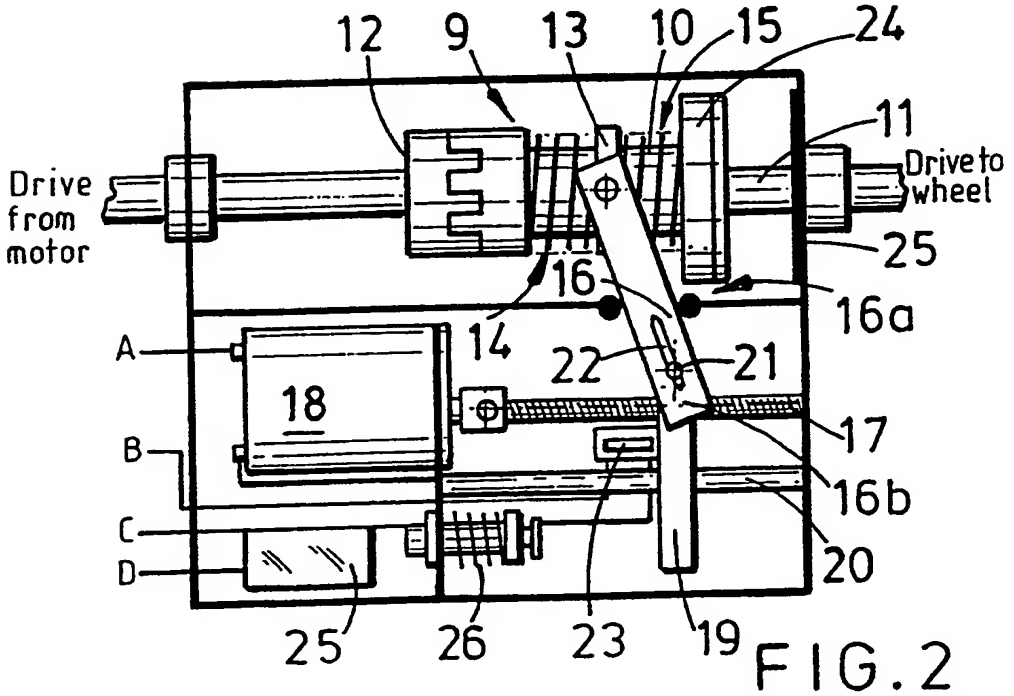
12
9
13
10
15
24
11
Drive from motor
Drive to wheel
25
16
16a
14
22
21
A
18
17
B
16b
C
20
D
25
26
23
19

FIG.2

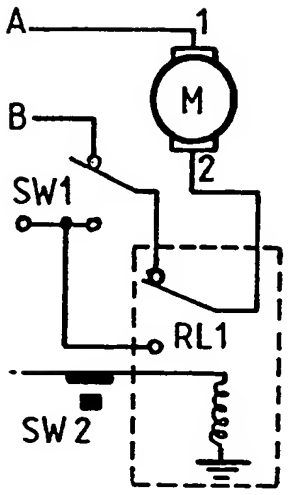

FIG. 3

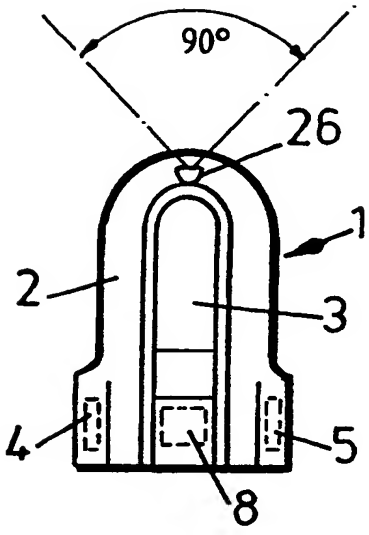

FIG. 5

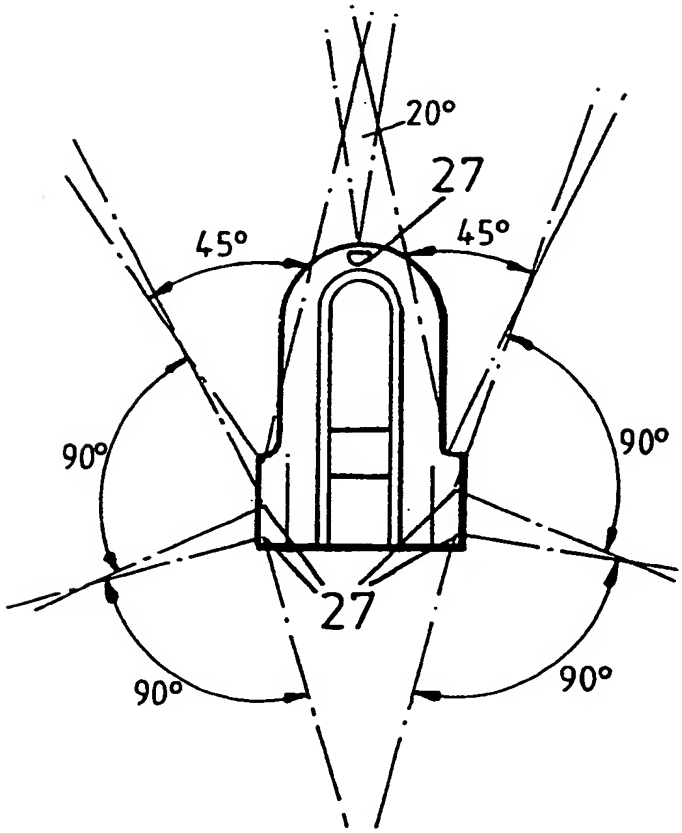

FIG. 6

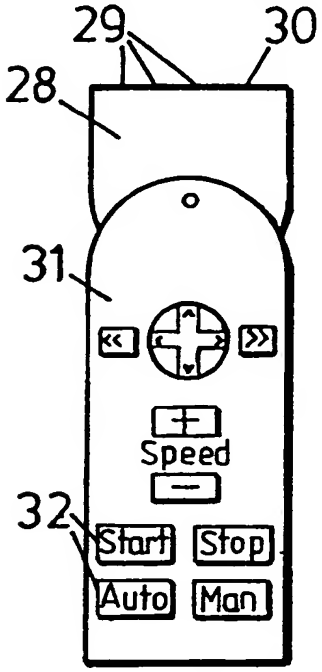

FIG. 7

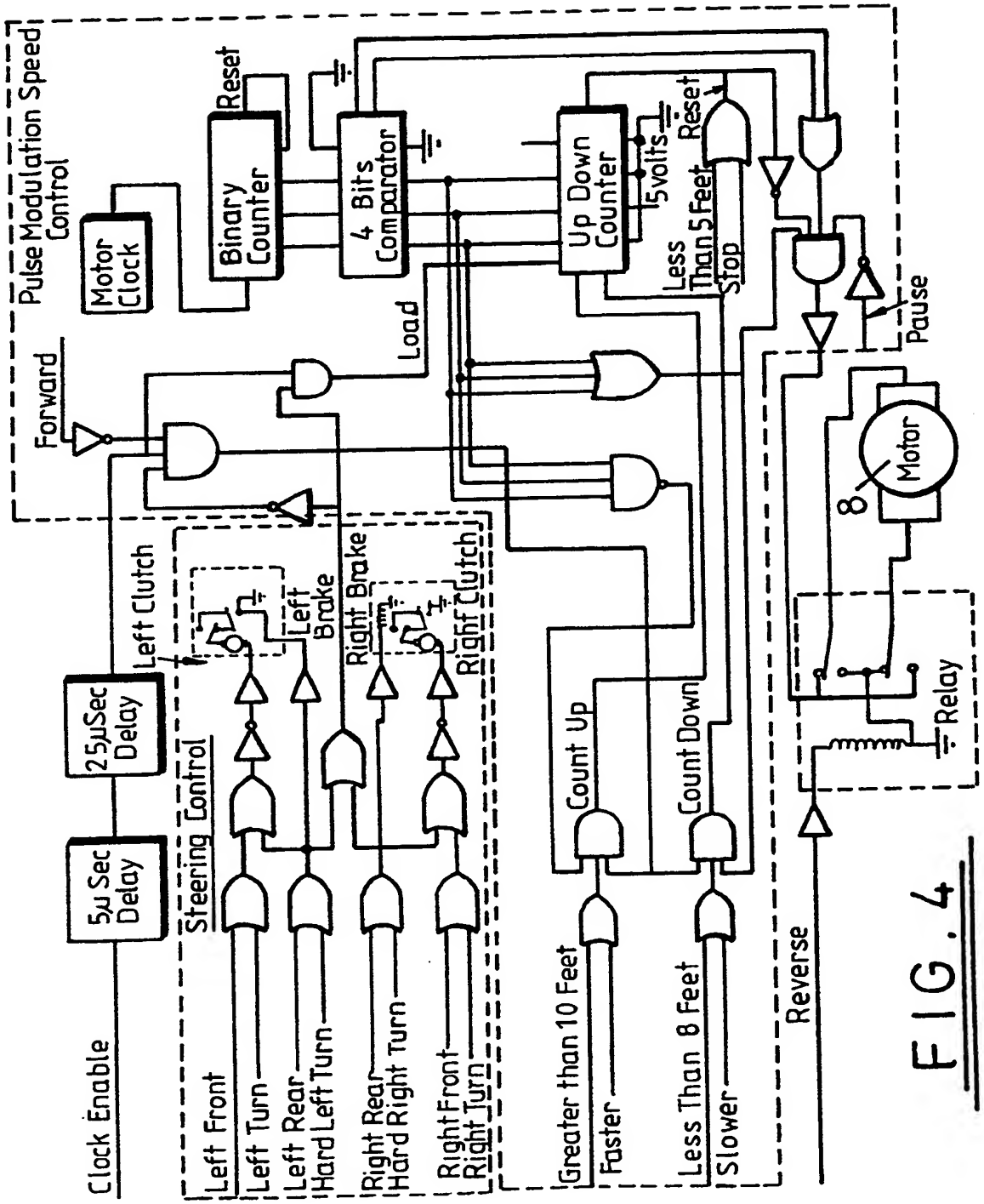
Pulse Modulation Speed Control
Motor Clock
Binary Counter
Reset
4 Bits Comparator
Load
Up Down Counter
5volts
Reset
Less Than 5 Feet Stop
Forward
Pause
Motor
8
Relay
Left Clutch
Left Brake
Right Brake
Right Clutch
25µSec Delay
5µ Sec Delay
Steering Control
Clock Enable
Left Front
Left Turn
Left Rear
Hard Left Turn
Right Rear
Hard Right Turn
Right Front
Right Turn
Count Up
Count Down
Greater than 10 Feet
Faster
Less Than 8 Feet
Slower
Reverse

FIG. 4

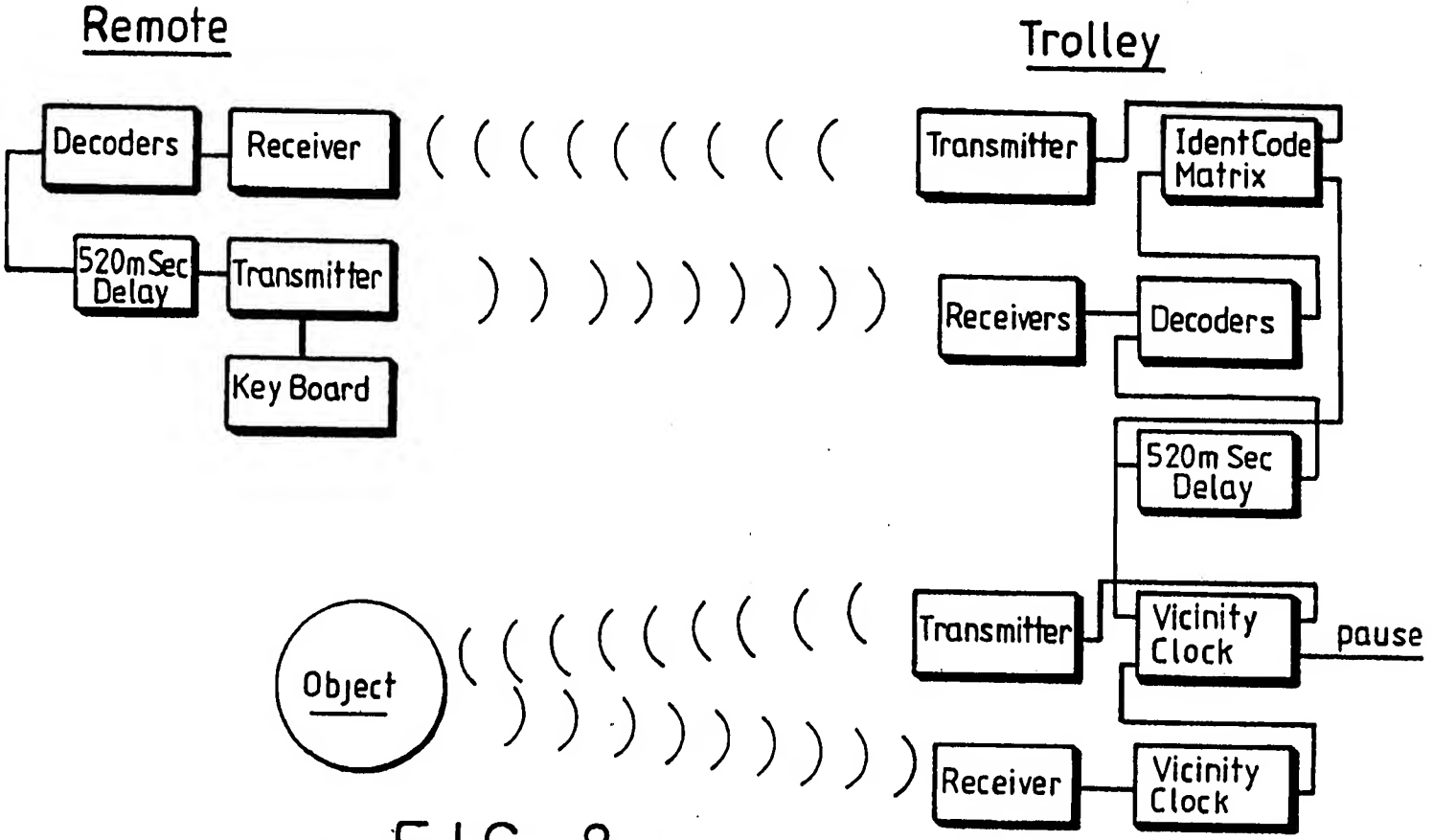
Remote
Trolley
Decoders
Receiver
520m Sec Delay
Transmitter
Key Board
Transmitter
Ident Code Matrix
Receivers
Decoders
520m Sec Delay
Object
Transmitter
Vicinity Clock
pause
Receiver
Vicinity Clock

FIG. 8

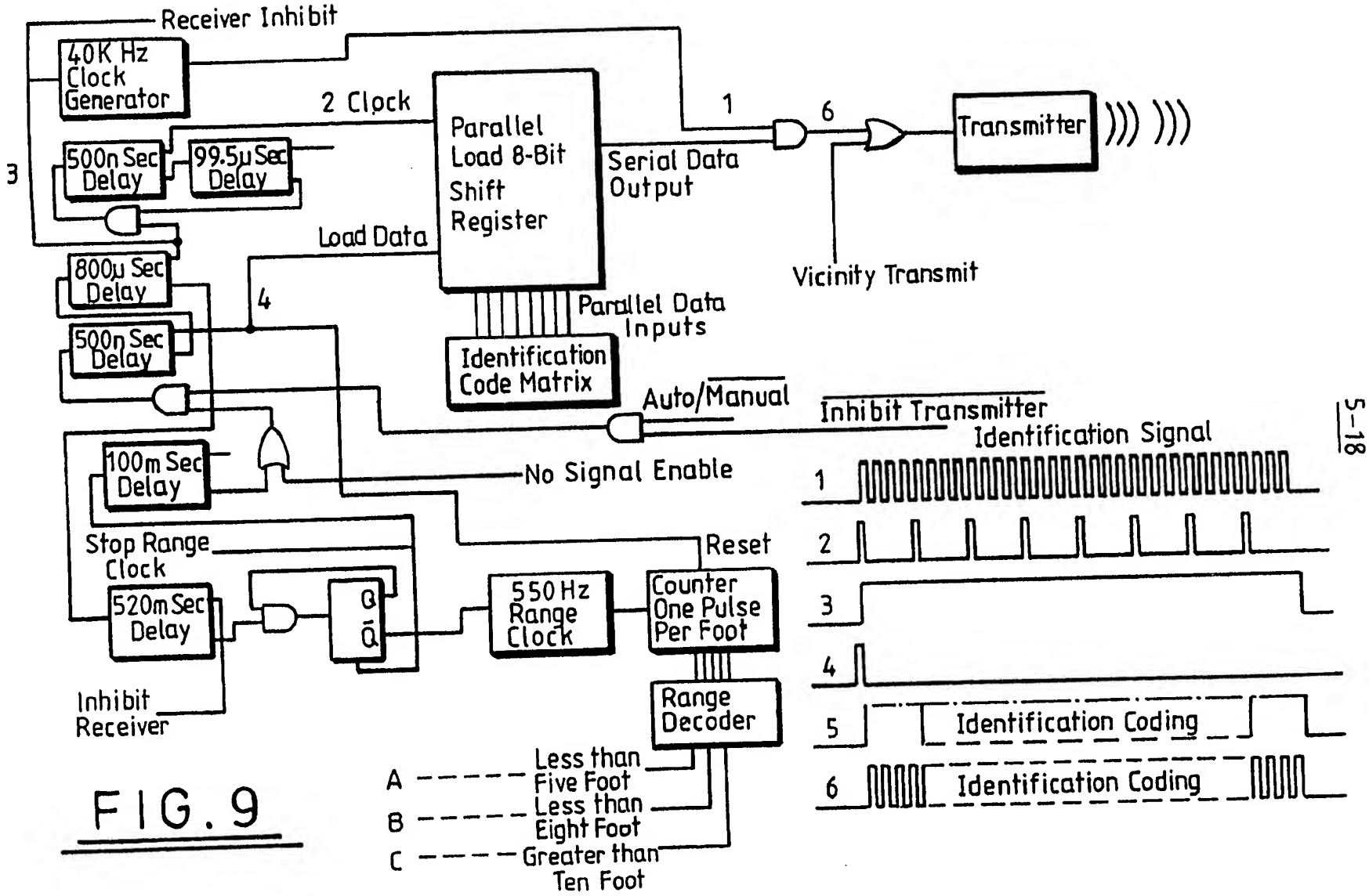
Receiver Inhibit
40K Hz Clock Generator
2 Clock
Parallel Load 8-Bit Shift Register
1
6
Transmitter
Serial Data Output
3
500n Sec Delay
99.5μ Sec Delay
Load Data
Vicinity Transmit
800μ Sec Delay
4
Parallel Data Inputs
500n Sec Delay
Identification Code Matrix
Auto/Manual
Inhibit Transmitter
100m Sec Delay
No Signal Enable
Stop Range Clock
Reset
520m Sec Delay
Q
Q̄
550 Hz Range Clock
Counter One Pulse Per Foot
Range Decoder
Inhibit Receiver
A ----- Less than Five Foot
B ----- Less than Eight Foot
C ----- Greater than Ten Foot
Identification Signal
1
2
3
4
5
Identification Coding
6
Identification Coding

FIG. 9

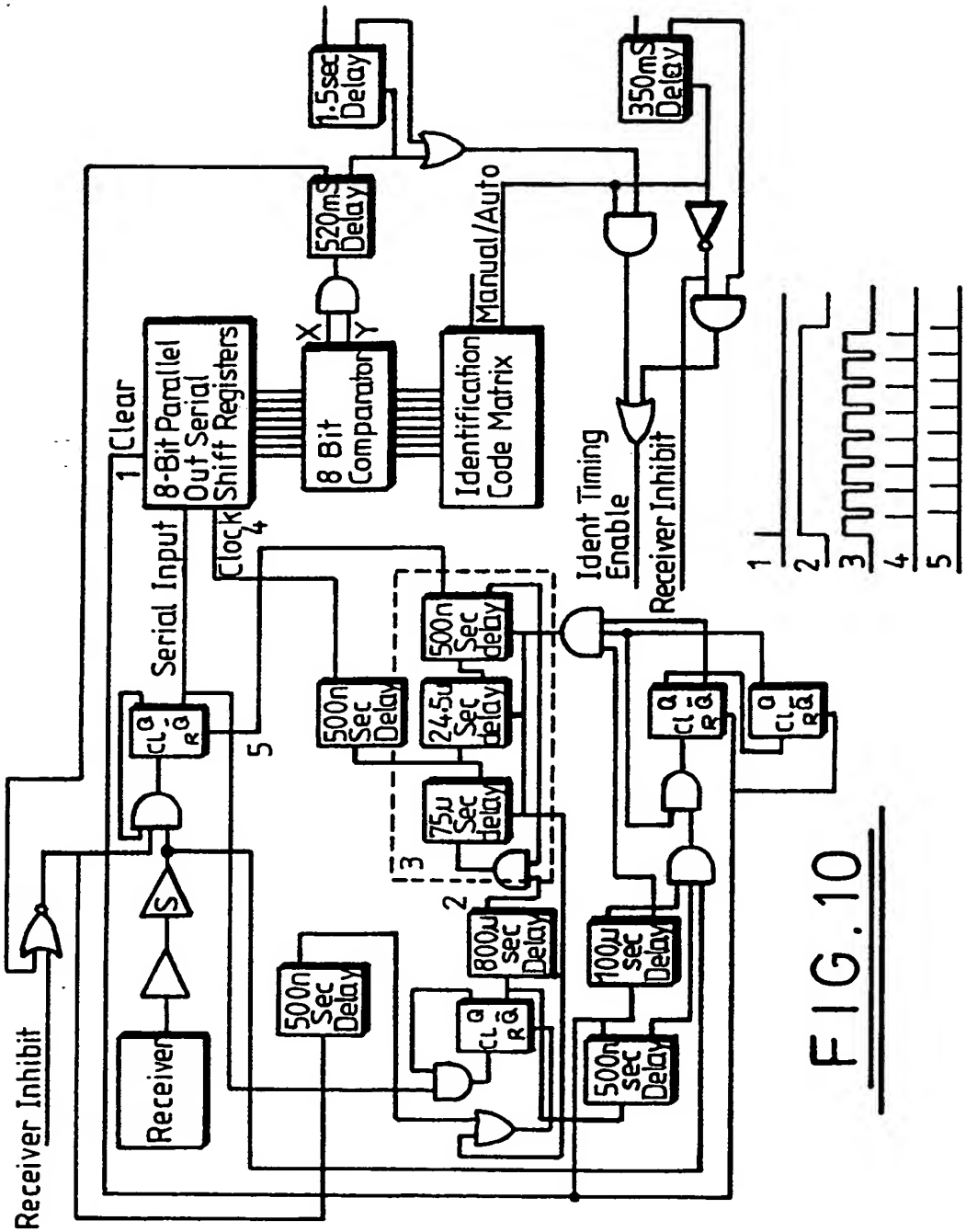
Receiver Inhibit
Receiver
S
Serial Input
1 Clear
8-Bit Parallel Out Serial Shift Registers
Clock
4
5
8 Bit Comparator
X
Y
520mS Delay
1.5sec Delay
Manual/Auto
Identification Code Matrix
Ident Timing Enable
Receiver Inhibit
350mS Delay
500n Sec Delay
24.5u Sec delay
75u Sec delay
500n Sec delay
800u sec Delay
100u sec Delay
500n sec Delay
500n Sec Delay
3
2
1
2
3
4
5

FIG. 10

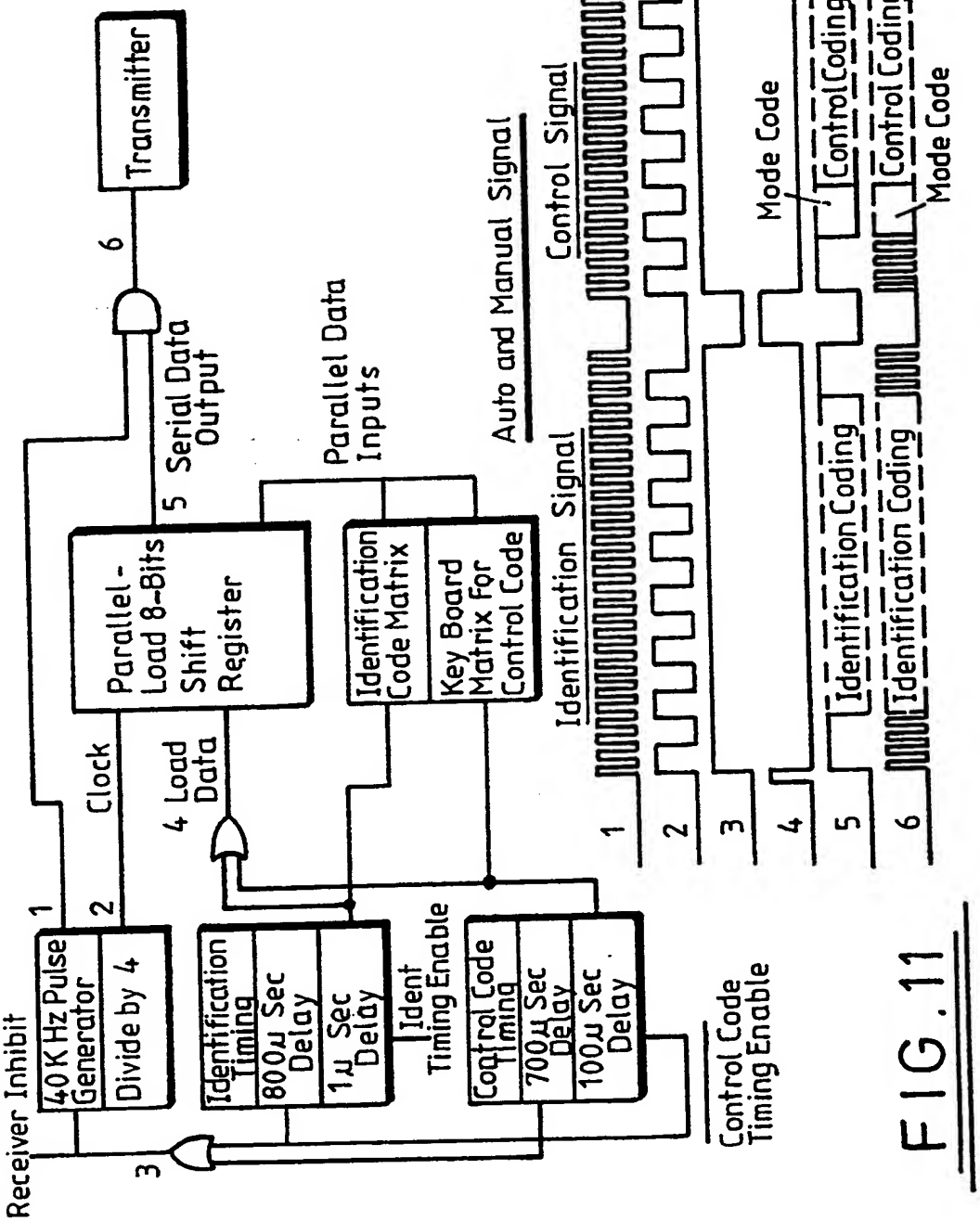
Receiver Inhibit
40 K Hz Pulse Generator
Divide by 4
Identification Timing
800μ Sec Delay
1μ Sec Delay
Ident Timing Enable
Control Code Timing
700μ Sec Delay
100μ Sec Delay
Control Code Timing Enable
Clock
4 Load Data
Parallel - Load 8-Bits Shift Register
Identification Code Matrix
Key Board Matrix For Control Code
Parallel Data Inputs
5 Serial Data Output
6
Transmitter
Auto and Manual Signal
Identification Signal
Control Signal
Identification Coding
Mode Code
Identification Coding
Control Coding
Identification Coding
Control Coding
Mode Code
1
2
3
4
5
6

FIG. 11

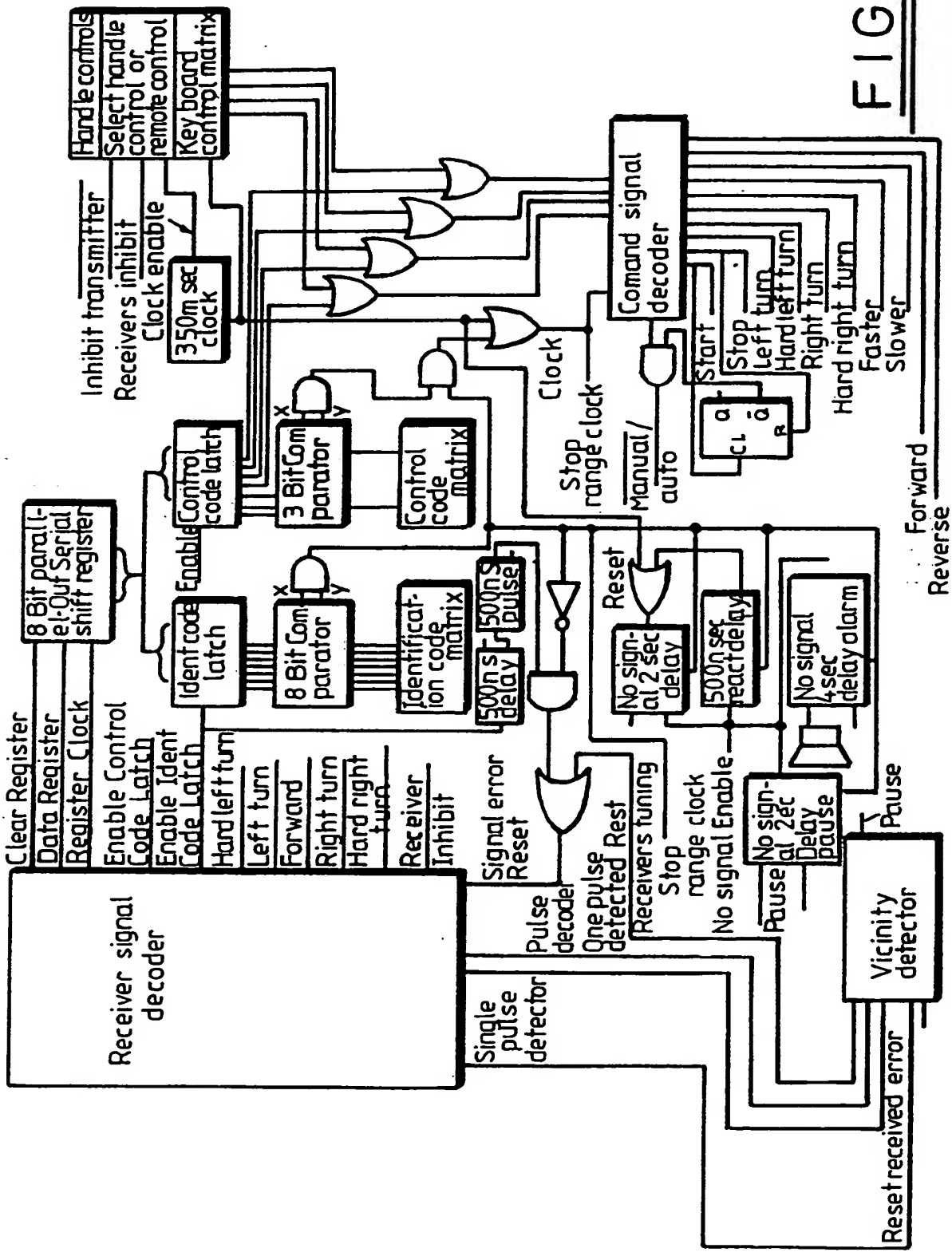
Handle controls
Select handle control or remote control
Key board control matrix
Inhibit transmitter
Receivers inhibit
Clock enable
350m sec clock
Comand signal decoder
Start
Stop
Left turn
Hard left turn
Right turn
Hard right turn
Faster
Slower
Forward
Reverse
Clock
Stop range clock
Manual/ auto
Control code latch
3 Bit Com parator
Control code matrix
Enable
8 Bit parall-el-Out Serial shift register
Ident code latch
8 Bit Com parator
Identificat-ion code matrix
500n sec Pulse
500n sec delay
Reset
No sign-al 2 sec delay
500n sec reactdelay
No signal 4 sec delay alarm
Clear Register
Data Register
Register Clock
Enable Control Code Latch
Enable Ident Code Latch
Hard left turn
Left turn
Forward
Right turn
Hard right turn
Receiver Inhibit
Signal error Reset
Receiver signal decoder
Pulse decoder
One pulse detected Rest
Receivers tuning
Stop range clock
No signal Enable
Pause
No sign-al 2sec Delay pause
Pause
Vicinity detector
Single pulse detector
Reset received error

FIG. 12

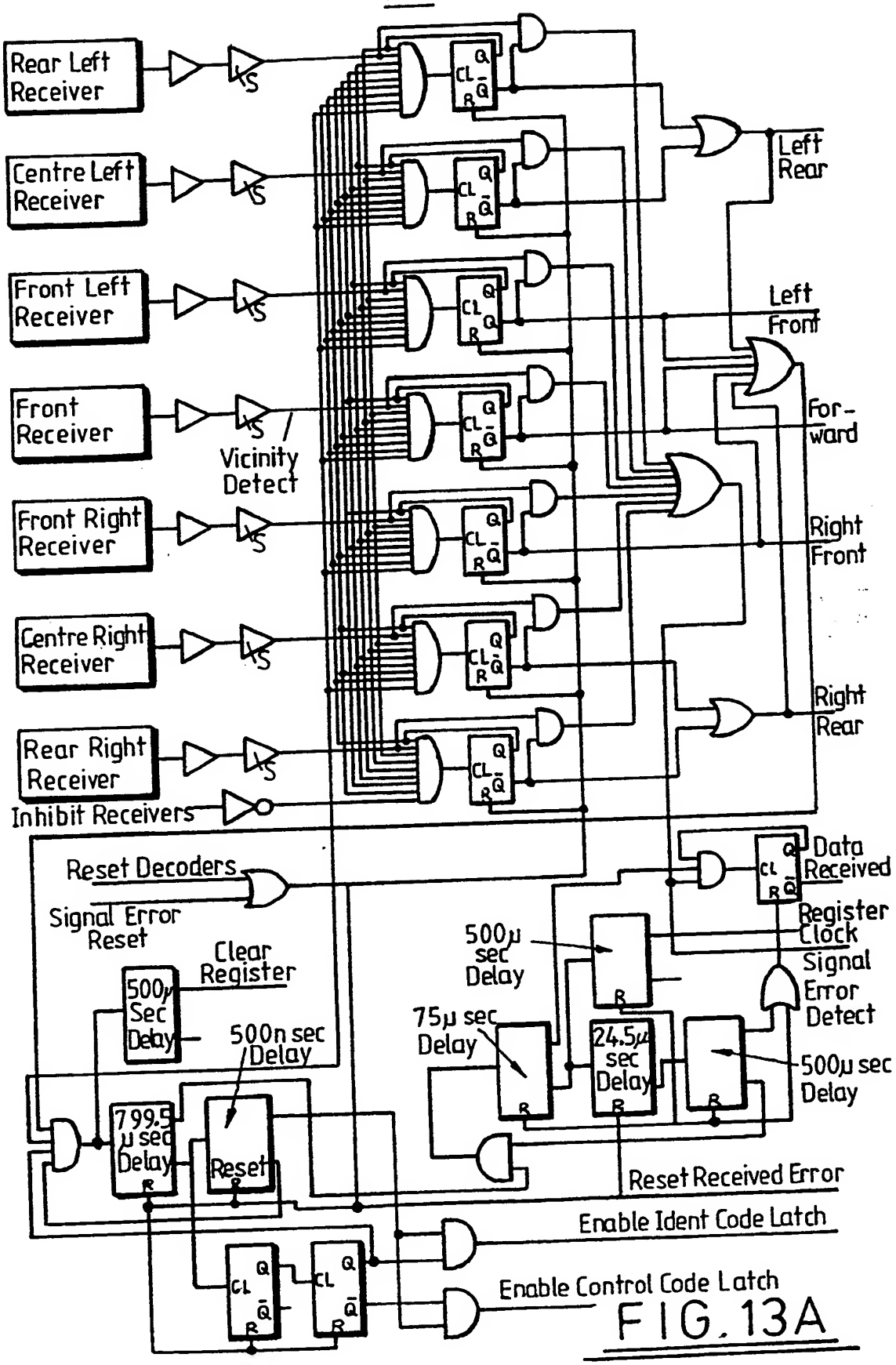
Rear Left Receiver
Centre Left Receiver
Front Left Receiver
Front Receiver
Vicinity Detect
Front Right Receiver
Centre Right Receiver
Rear Right Receiver
Inhibit Receivers
Left Rear
Left Front
For-ward
Right Front
Right Rear
Reset Decoders
Signal Error Reset
Clear Register
500μ Sec Delay
500n sec Delay
799.5 μ sec Delay
Reset
500μ sec Delay
75μ sec Delay
24.5μ sec Delay
500μ sec Delay
Data Received
Register Clock
Signal Error Detect
Reset Received Error
Enable Ident Code Latch
Enable Control Code Latch

FIG. 13A

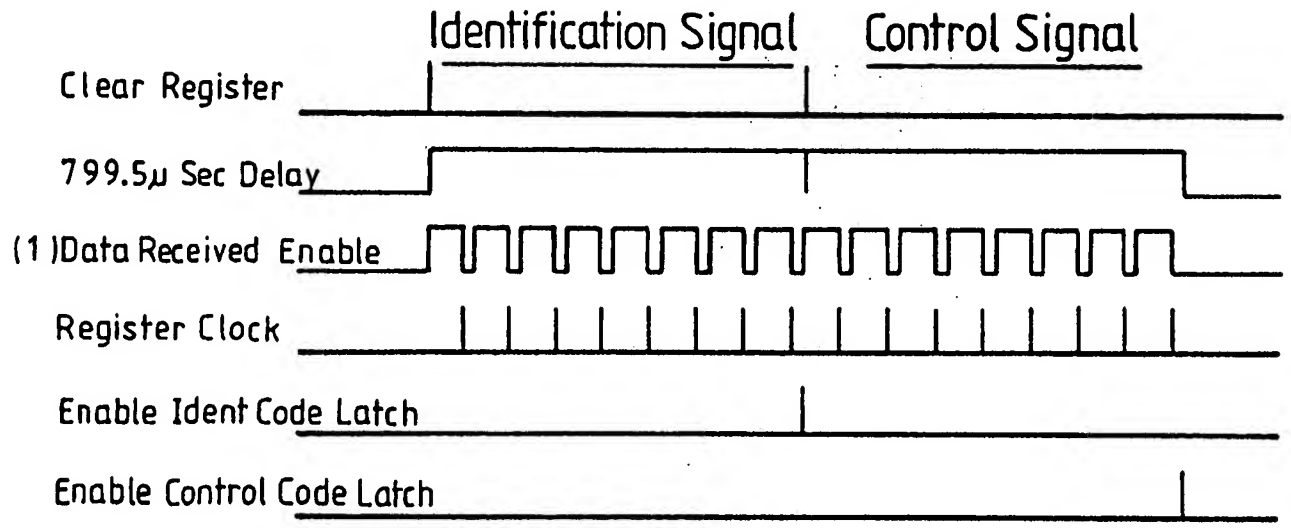
Identification Signal
Control Signal
Clear Register
799.5μ Sec Delay
(1)Data Received Enable
Register Clock
Enable Ident Code Latch
Enable Control Code Latch

FIG. 13B

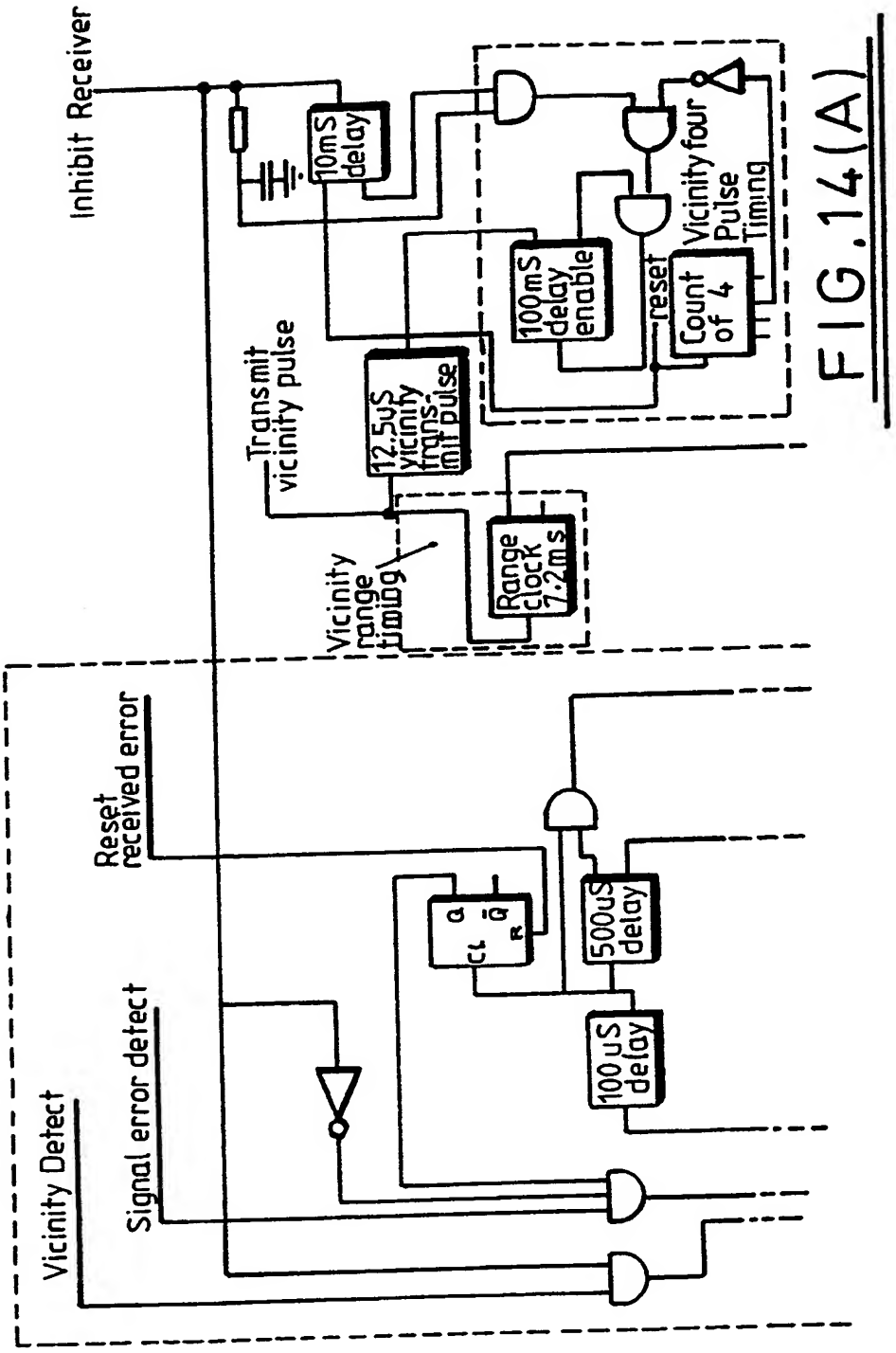
Inhibit Receiver
10mS delay
Vicinity four Pulse Timing
100mS delay enable
reset
Count of 4
Transmit vicinity pulse
12.5uS vicinity transmit pulse
Vicinity range timing
Range clock 7.2ms
Reset received error
Q
Cl
R
500uS delay
100uS delay
Signal error detect
Vicinity Detect

FIG.14(A)

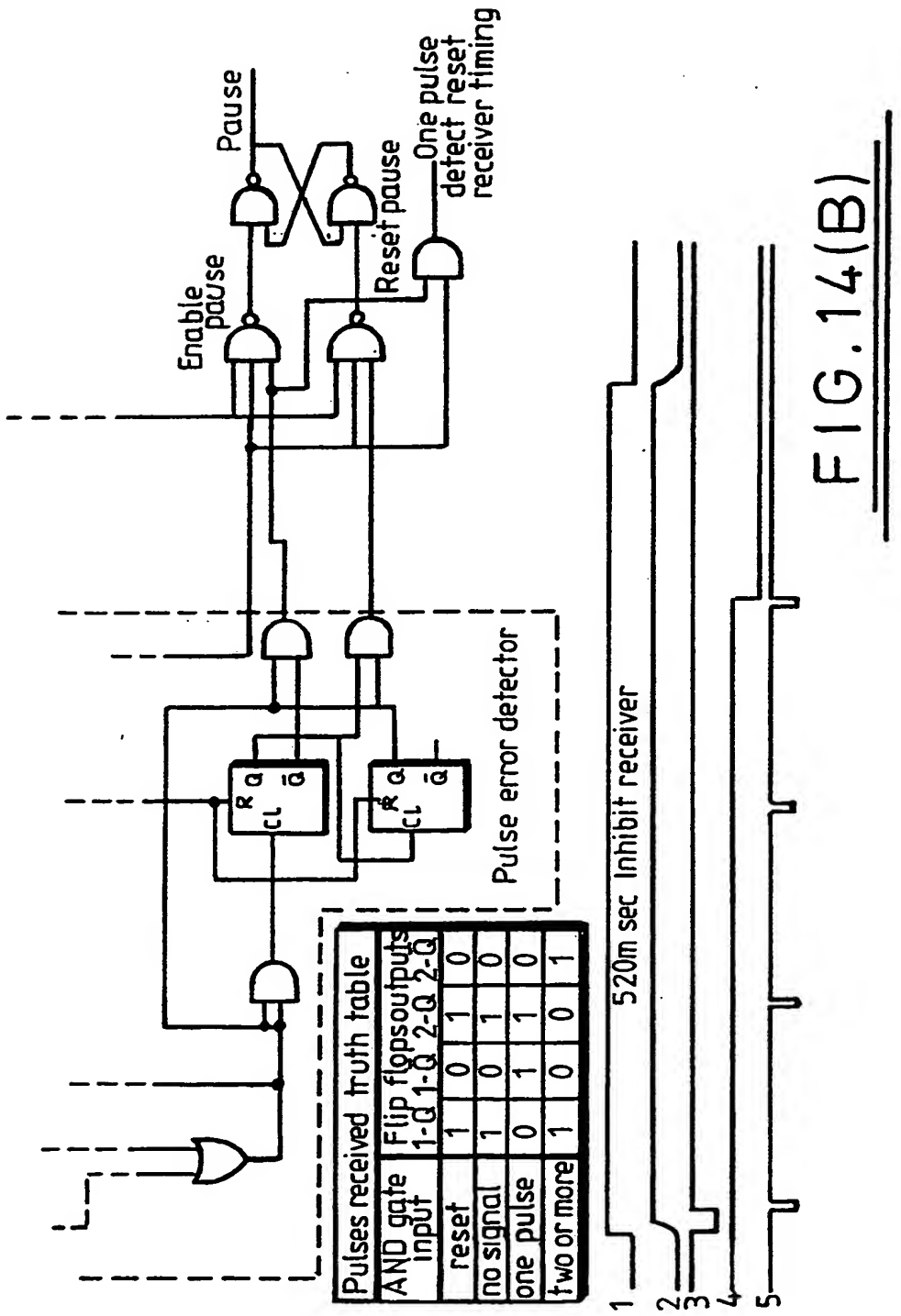
Pause
Enable pause
Reset pause
One pulse detect reset receiver timing
Pulse error detector
Pulses received truth table
AND gate input
Flip flopsoutputs 1-Q 1-Q 2-Q 2-Q
reset 1 0 1 0
no signal 1 0 1 0
one pulse 0 1 1 0
two or more 1 0 0 1
1
520m sec Inhibit receiver
2
3
4
5

FIG.14(B)

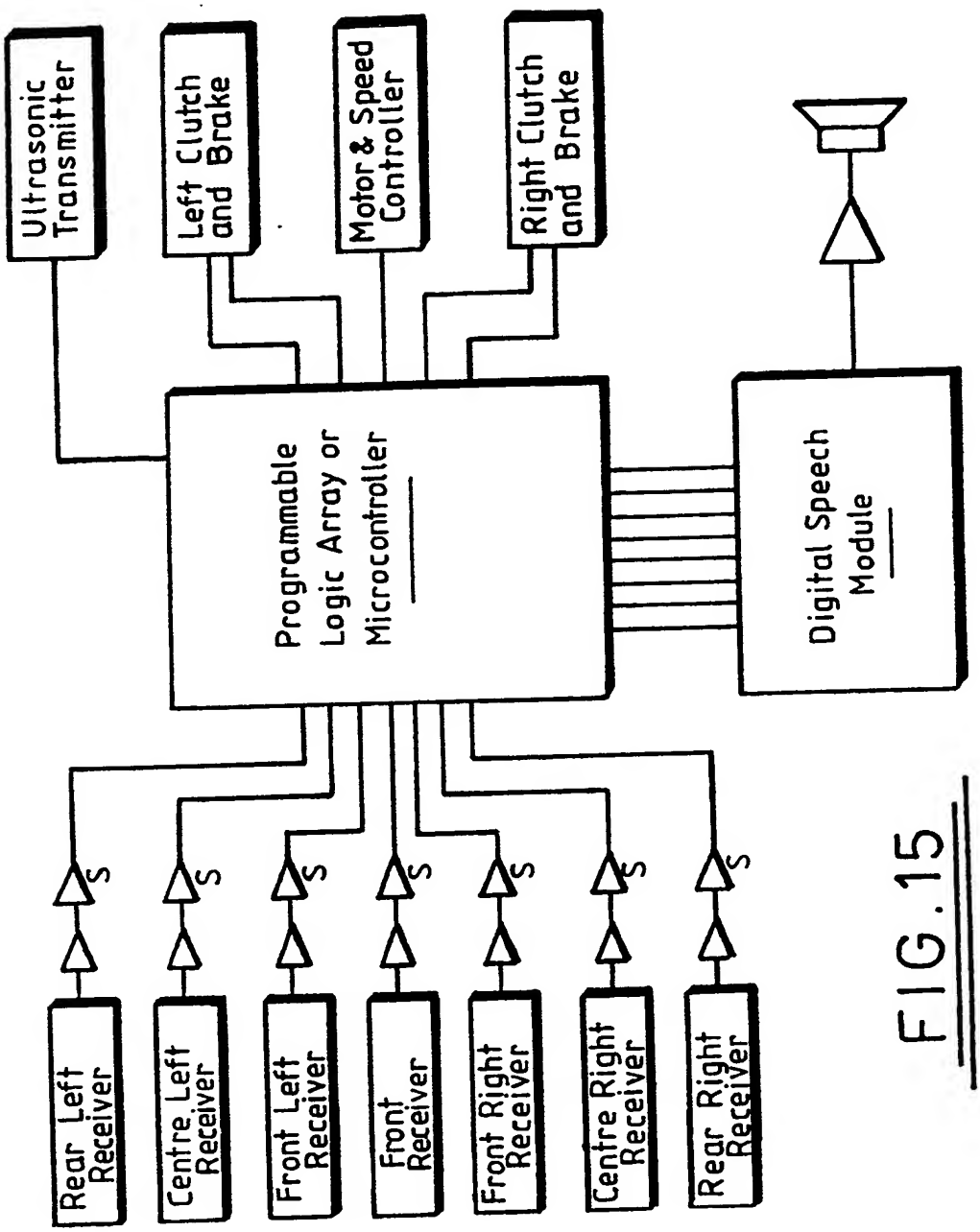
Ultrasonic Transmitter
Left Clutch and Brake
Motor & Speed Controller
Right Clutch and Brake
Programmable Logic Array or Microcontroller
Digital Speech Module
Rear Left Receiver
Centre Left Receiver
Front Left Receiver
Front Receiver
Front Right Receiver
Centre Right Receiver
Rear Right Receiver

FIG. 15

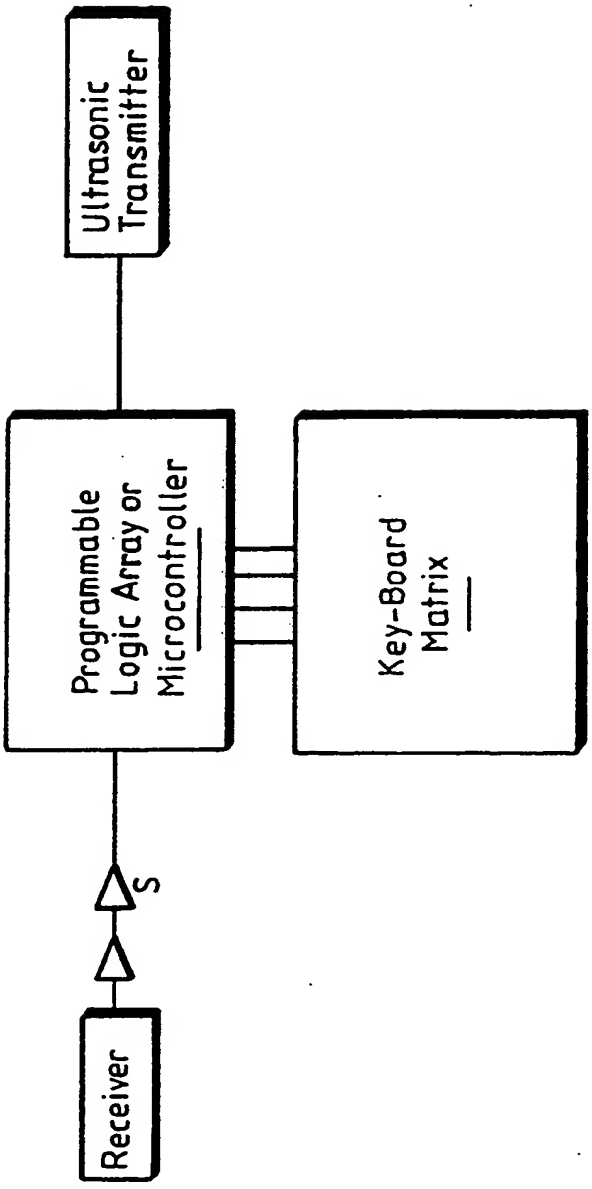
Ultrasonic Transmitter
Programmable Logic Array or Microcontroller
Key-Board Matrix
S
Receiver

FIG.16

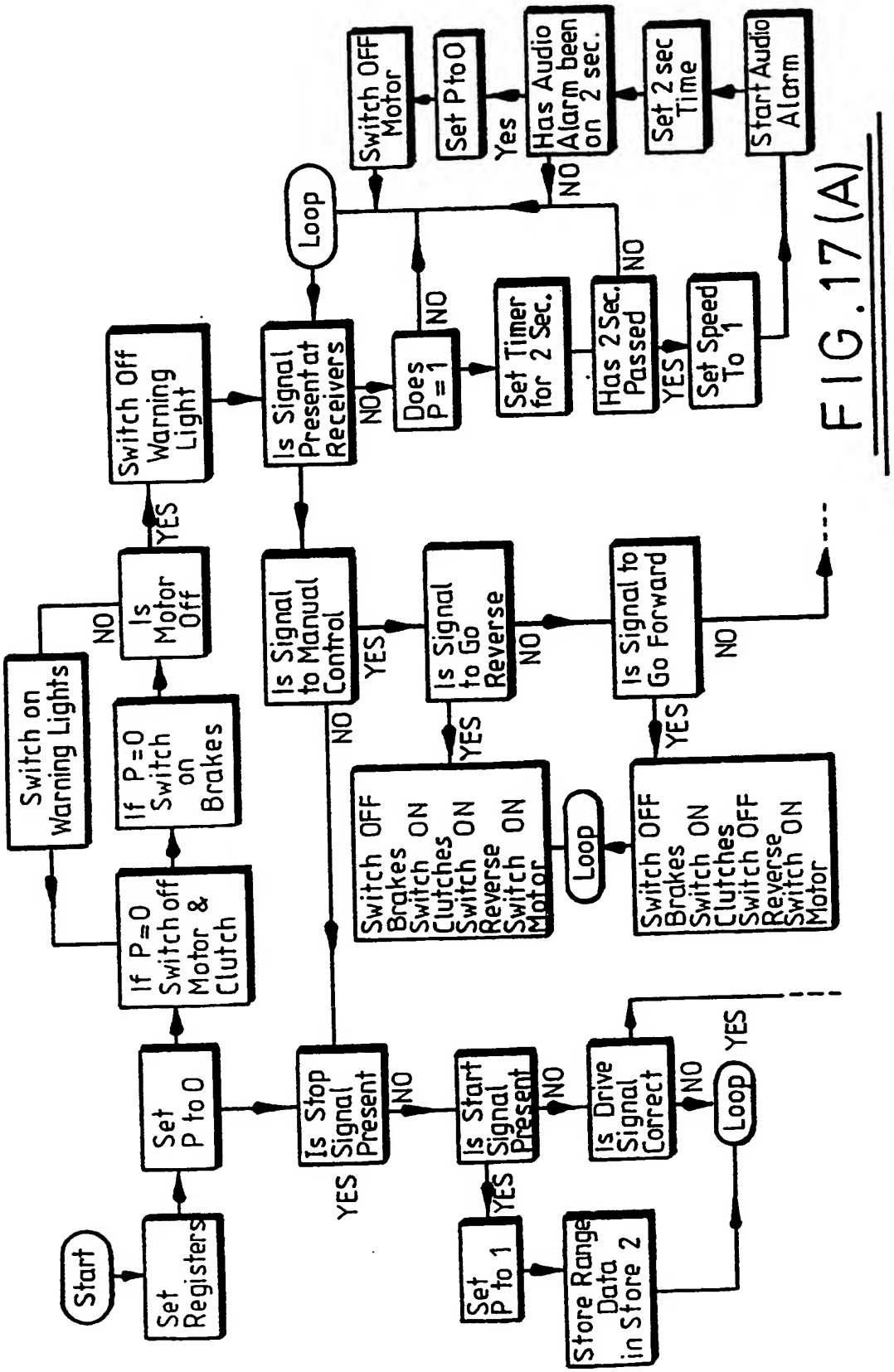
Start
Set Registers
Set P to 0
If P=0 Switch off Motor & Clutch
Switch on Warning Lights
If P=0 Switch on Brakes
Is Motor Off
NO
YES
Switch Off Warning Light
Is Stop Signal Present
NO
YES
Is Start Signal Present
NO
YES
Set P to 1
Is Drive Signal Correct
NO
YES
Loop
Store Range Data in Store 2
Is Signal Present at Receivers
NO
Does P=1
NO
Set Timer for 2 Sec.
Has 2 Sec. Passed
NO
YES
Set Speed To 1
Loop
Switch OFF Motor
Set P to 0
Yes
Has Audio Alarm been on 2 sec.
NO
Set 2 sec Time
Start Audio Alarm
Is Signal to Manual Control
YES
NO
Is Signal to Go Reverse
NO
YES
Switch OFF Brakes Switch ON Clutches Switch ON Reverse Switch ON Motor
Loop
Is Signal to Go Forward
NO
YES
Switch OFF Brakes Switch ON Clutches Switch OFF Reverse Switch ON Motor

FIG. 17 (A)

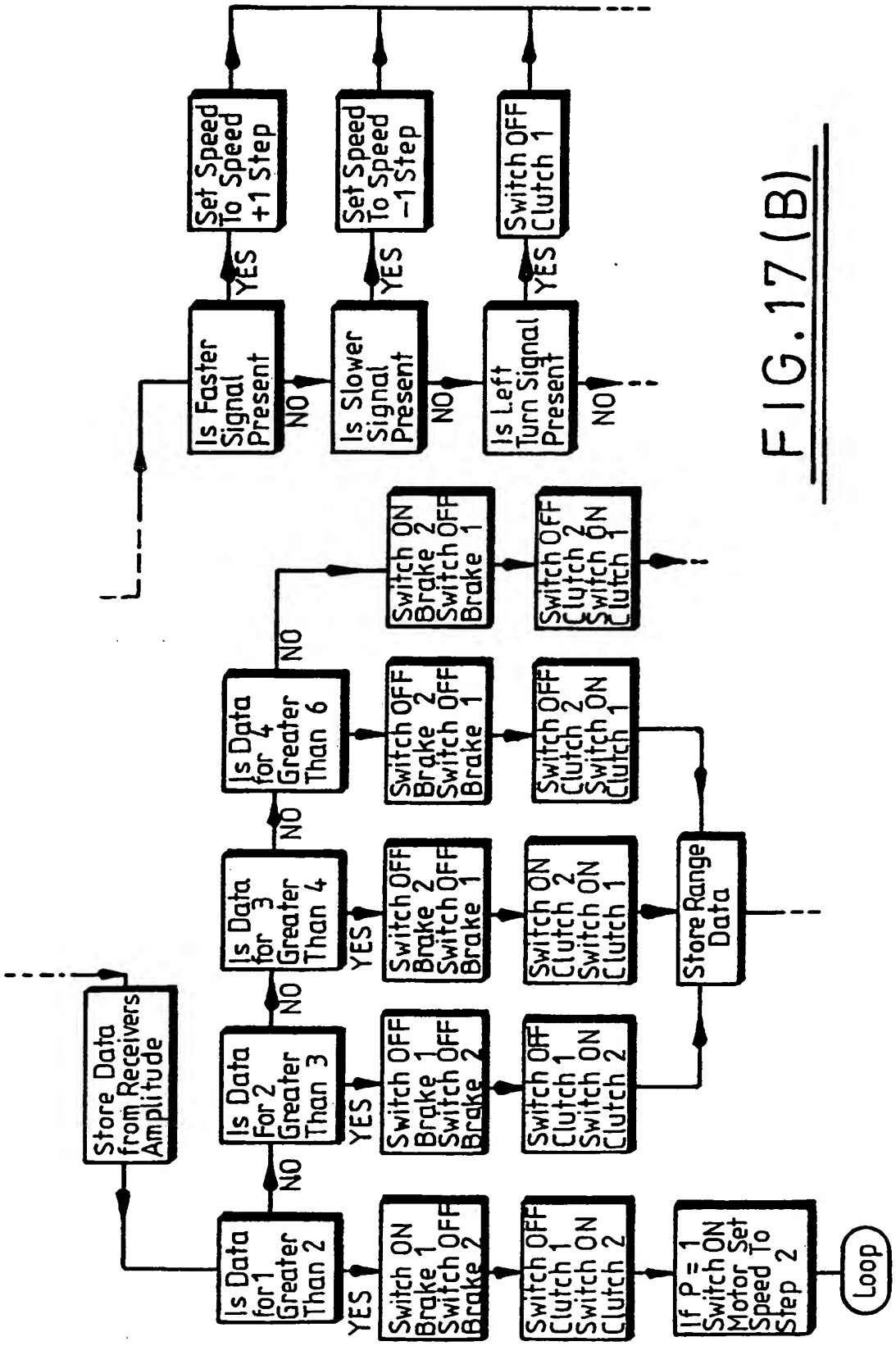
Store Data from Receivers Amplitude
Is Data for 1 Greater Than 2
YES
Switch ON Brake 1 Switch OFF Brake 2
Switch OFF Clutch 1 Switch ON Clutch 2
If P = 1 Switch ON Motor Set Speed To Step 2
Loop
NO
Is Data For 2 Greater Than 3
YES
Switch OFF Brake 1 Switch OFF Brake 2
Switch OFF Clutch 1 Switch ON Clutch 2
NO
Is Data for 3 Greater Than 4
YES
Switch OFF Brake 2 Switch OFF Brake 1
Switch ON Clutch 2 Switch ON Clutch 1
NO
Is Data for 4 Greater Than 6
Switch OFF Brake 2 Switch OFF Brake 1
Switch OFF Clutch 2 Switch ON Clutch 1
NO
Switch ON Brake 2 Switch OFF Brake 1
Switch OFF Clutch 2 Switch ON Clutch 1
Store Range Data
Is Faster Signal Present
YES
Set Speed To Speed +1 Step
NO
Is Slower Signal Present
YES
Set Speed To Speed -1 Step
NO
Is Left Turn Signal Present
YES
Switch OFF Clutch 1
NO

FIG.17(B)

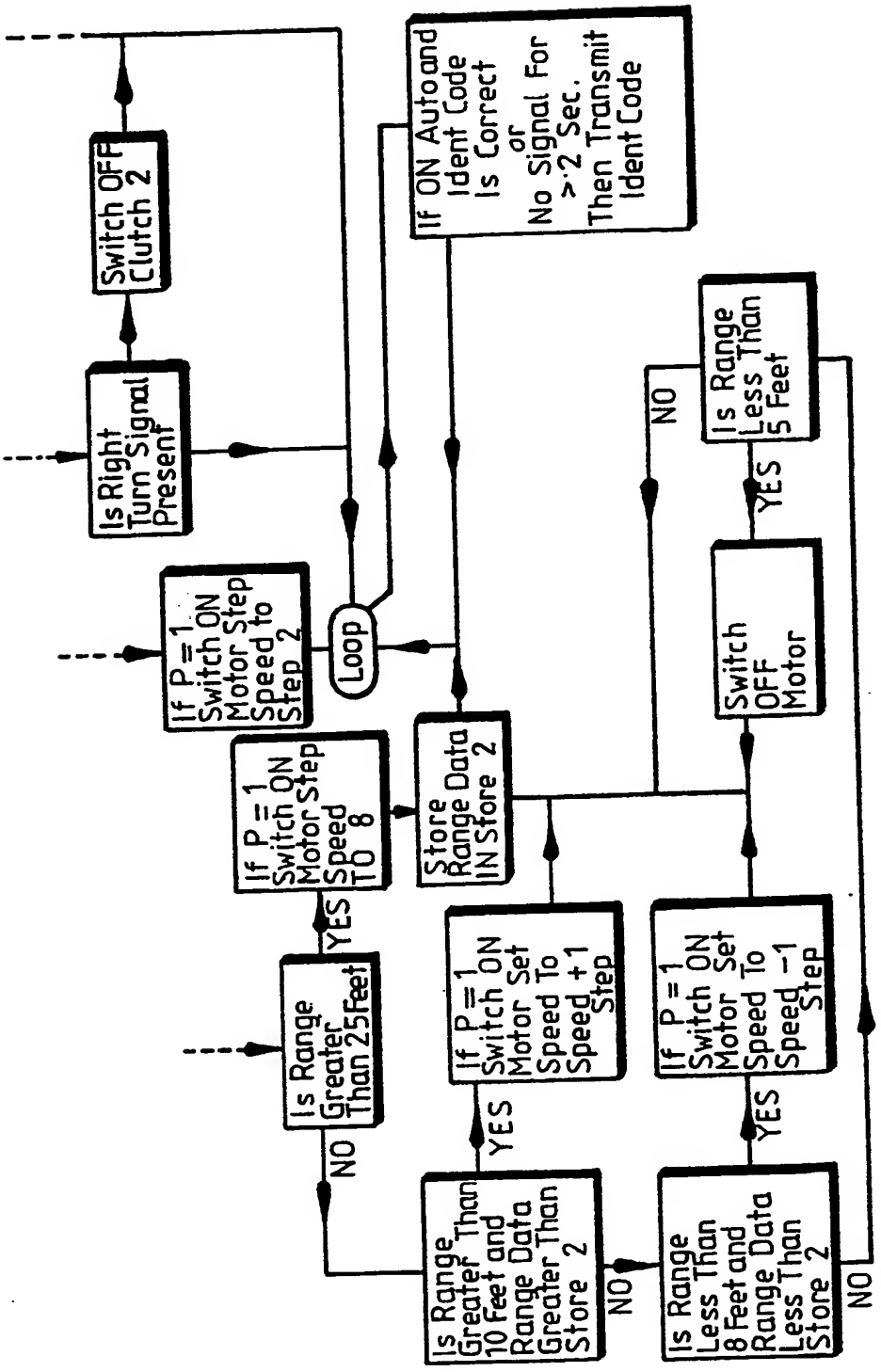
Switch OFF Clutch 2
Is Right Turn Signal Present
If P=1 Switch ON Motor Step Speed to Step 2
Loop
If ON Autoand Ident Code Is Correct or No Signal For >2 Sec. Then Transmit Ident Code
If P=1 Switch ON Motor Step Speed TO 8
Store Range Data IN Store 2
Is Range Less Than 5 Feet
NO
YES
Switch OFF Motor
Is Range Greater Than 25Feet
YES
NO
If P=1 Switch ON Motor Set Speed To Speed +1 Step
If P=1 Switch ON Motor Set Speed To Speed -1 Step
Is Range Greater Than 10 Feet and Range Data Greater Than Store 2
Is Range Less Than 8 Feet and Range Data Less Than Store 2
YES
NO
NO

FIG.17(C)

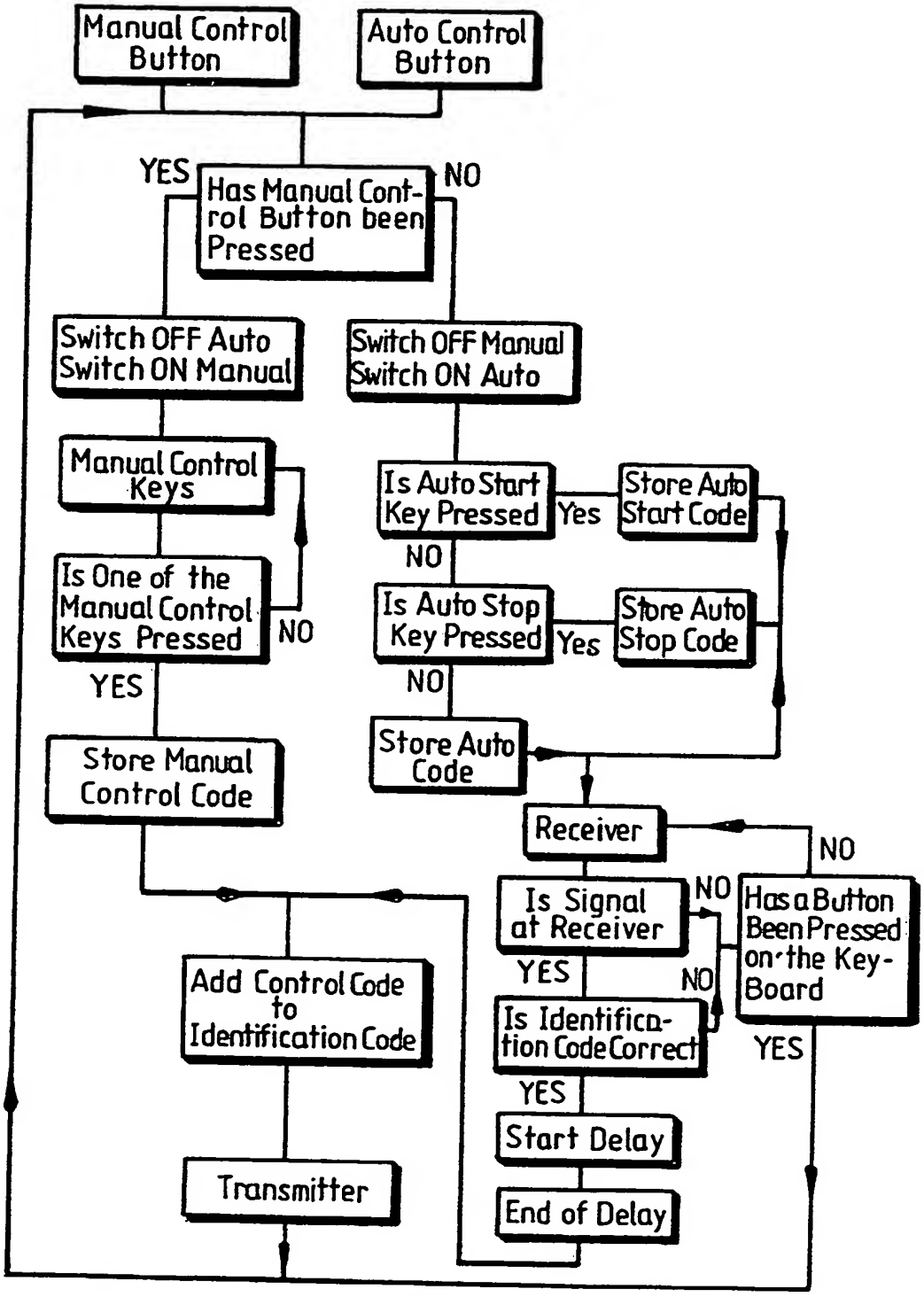
Manual Control Button
Auto Control Button
YES
Has Manual Control Button been Pressed
NO
Switch OFF Auto Switch ON Manual
Switch OFF Manual Switch ON Auto
Manual Control Keys
Is One of the Manual Control Keys Pressed
NO
YES
Store Manual Control Code
Is Auto Start Key Pressed
Yes
Store Auto Start Code
NO
Is Auto Stop Key Pressed
Yes
Store Auto Stop Code
NO
Store Auto Code
Receiver
NO
Is Signal at Receiver
NO
YES
Has a Button Been Pressed on the Key-Board
NO
YES
Is Identification Code Correct
YES
Start Delay
End of Delay
Add Control Code to Identification Code
Transmitter

FIG. 18

MOTORIZED CARRIERS

The present invention relates to motorized carriers, in particular, though not necessarily, golf trolleys, and to an automatic motorized carrier control system.

Motorized golf trolleys have gained increasing popularity in recent years, and there is now a desire for an automatic golf trolley control system which allows hands free operation of the trolley. In order that the trolley should keep at a safe distance behind its owner any such system should make use of a range-finder system. One range-finder system which is commonly used in other application uses infra-red radiation. However, infra-red range-finders generally use narrow signal beam widths, so that communication is easily lost, and have relatively high power consumption. In addition, infra-red systems are susceptible to being swamped by strong sunlight. Alternative systems use ultrasonic radiation allowing a substantially wider beam width to be used and having lower power requirement. However, ultrasonic systems are highly susceptible to interference due to reflection from bodies in the vicinity of the transmitter and stray emissions from electrical equipment, e.g. golf trolley motors and animals.

The present invention makes use of a new improved ultrasonic range-finder system which seeks to avoid one or more of the above mentioned problems and disadvantages.

According to a first aspect of the present invention there is provided an automatic motorized carrier control system for controlling the motor drive means of a carrier to maintain a substantially fixed separation distance between the carrier and an operator, the system comprising:

ultrasonic transmitter and receiver means and interrogation control means for mounting on the carrier, the interrogation control means being arranged to periodically enable an interrogation mode in which the carrier transmitter is activated to transmit an ultrasonic identification code and the carrier receiver is disabled for a predetermined period of time;

a remote control unit arranged to be carried by the operator and comprising ultrasonic transmitter and receiver means and identification code recognition means, the identification code recognition means being arranged to compare a received identification code with a stored code and, if the received code and the stored code match, to disable the remote ultrasonic receiver and to transmit an ultrasonic carrier control signal after a predetermined delay for reception by the carrier ultrasonic receiver means in a time period following the interrogation mode; and

timing control means coupled to the carrier ultrasonic transmitter and receiver means and the interrogation control means for calculating the time delay between transmission of the identification code

and reception of the control signal and for calculating therefrom the separation distance of the carrier and the operator.

According to a second aspect of the present invention there is provided an automatic motorized carrier control system comprising range-finder means for monitoring the separation of the carrier from a remote unit carried by the user of that carrier and carrier drive control means coupled to said range-finder means and formed and arranged for enabling and disabling drive of the motorized carrier above and below a predetermined separation, the range-finder means comprising a two-way ultrasonic communications system with carrier transmitter and receiver means and remote unit transmitter and receiver means and the carrier transmitter means comprising an interrogation control means for periodically enabling an interrogation mode in which the carrier transmitter sends an identification code corresponding to that of the associated remote unit, and the carrier receiver is disabled for a predetermined period of time, the remote unit receiver means comprising identification code recognition means formed and arranged for comparing the identification code received from the carrier with a stored predetermined identification code, and upon recognition of a match confirming that said carrier is one required to follow said remote unit, disabling the remote unit receiver means and enabling a response mode wherein a

carrier control signal is transmitted after a predetermined time delay, said interrogation control means being formed and arranged so that the interrogation mode is disabled during a period allowing reception of transmissions from the remote unit in its response mode, said carrier receiver means being provided with timing means formed and arranged for measuring the time delay in receiving the carrier control signal due to the remote unit separation from the carrier to provide an indication of said separation, whereby in use, the carrier may follow its associated remote unit at a generally predetermined distance.

Where the carrier is required to follow a non-linear path, for example where the carrier is a golf trolley, the carrier control system may include means for indicating the required direction of travel. This may conveniently be achieved by using a plurality of directional receivers on the carrier for selectively receiving carrier control signals from different directions whereby the control system may determine (with the aid of suitable processing means) the required direction of travel.

As already noted hereinbefore, previously known systems suffered from various disadvantages and problems including difficulties in effective communications. In accordance with the present invention the latter may be substantially overcome by inter alia careful control of the ultrasonics communications between the carrier and

the respective remote unit. Thus in the first place the carrier sends an identification code unique to the particular remote unit which the carrier is required to follow in order selectively to activate the remote unit transmitter thereof thereby to restrict the signals which may be directed to the carrier. In addition the carrier receiver(s) are disabled during this interrogation phase so that any stray reflections of the carrier transmitter signals may be simply ignored. Once the remote unit has received the correct identification signal, from the carrier which is intended to follow that remote unit, the remote unit is enabled for responding after a predetermined interval to allow the carrier to exit its interrogation mode and re-enable its receiver(s). In this response mode the remote unit receiver is disabled to prevent initiation of any fresh response cycles and to ensure that the timing of the remote unit response signal is linked to a specific interrogation signal thereby to facilitate relating of the timing of these signals to the separation of the carrier and the remote unit.

With the above described arrangement the total time delay (t_{tot}) between transmission of an interrogation signal from the carrier and reception of a response signal from the remote unit at the carrier will correspond approximately to: $t_{tot} = t_1 + t_2 + t_3$ where t_1 and t_3 are the times required for the interrogation and response signals to pass from the carrier to the remote

unit and vice versa respectively and t_2 is the predetermined time delay after receipt of the interrogation signal at the remote unit and enabling of the response mode. The signal passage times t_1 and t_3 are related to the separation between the carrier and response unit in the following way:

$t_1 = t_3 = d/v$ where d is the carrier remote control unit separation and v the velocity of the ultrasonic transmission. The latter will be subject to some slight variations due to changes in air temperature and pressure etc but for practical purposes will generally be constant for a given system. Accordingly the separation may be readily determined by the following expression:

$$d = (t_{tot} - t_2).V/2$$

It will be appreciated that the main body of the carrier can have any of a wide variety of different forms depending on what is required to be carried, the terrain to be covered (possibly even water), the ambient operating conditions (indoors/outdoors), etc. without significantly affecting the fundamental nature of the carrier control system itself.

For the sake of brevity only one application will be described hereinbelow in detail but it will be clearly understood that various other applications are also within the scope of the present invention, for example supermarket trolleys and produce collection carts for use in fruit or vegetable harvesting.

Although the carrier control system of the present invention may be used simply to advance a carrier forward whenever the remote control unit exceeds a predetermined distance ahead of it, additional control features may readily be incorporated. In particular, where, as noted above, the user carrying the remote control unit follows a non-linear path and deviations to left or right of a directly forward direction are detected via the carrier receivers, the control system advantageously includes "steering means". This means may readily be implemented in various ways, e.g. by varying the drive speed at the left and right sides of the carrier.

Additional control facilities may be provided on the remote control unit including switch means for remote activation and/or deactivation of the carrier to bring it into interrogation mode; speed control means to vary the basic drive speed of the carrier; switch means for switching between automatic (following) and manual operation to allow the user to disable automatic following; manual steering means for driving the carrier manually to left or right; and reversing means for switching the carrier to reverse drive where it is desired to increase separation temporarily, e.g. in order to move a carrier which has followed a remote control unit onto a green back off the green.

According to a third aspect of the present invention there is provided a clutch mechanism for

coupling a motor drive shaft to a shaft to be driven by causing relative linear movement between the two shafts, the mechanism comprising an electric motor, a threaded shaft coupled to the motor for rotation thereby and extending in a direction substantially parallel to the direction of said relative linear movement, and link means threadably engaging the threaded shaft and coupled to one of the drive shaft and the driven shaft, wherein rotation of the threaded shaft causes relative movement of the link means which in turn causes said relative linear movement between the drive shaft and the driven shaft.

It will be understood that the detailed implementation of the generation, timing, control and processing of the interrogation and response signals, and application thereof to the motor and steering control of the carrier, can readily be effected using various techniques well known in the art.

Further preferred features and advantages of the invention will now be described in detail with reference to a golf trolley application illustrated by the accompanying drawings in which:

Fig. 1 is a perspective view of a golf trolley provided with a carrier control system;

Fig. 2 shows a clutch and brake assembly of the trolley of Fig 1;

Fig. 3 shows in circuit form the switching control means of the assembly of Fig 2;

Fig. 4 is a circuit diagram of a steering and motor control system of the golf trolley of Fig 1.

Fig. 5 is a plan view of the carrier of Figure 1 showing the position of an ultrasonic transmitter;

Fig. 6 is a plan view of the carrier of Figure 1 showing the positions of a plurality of ultrasonic receivers;

Fig. 7 is a plan view of a remote control unit of the carrier control system of the golf trolley of Fig 1;

Fig. 8 shows a schematic overview of the carrier control system Fig. 1;

Fig.9 shows a carrier transmission circuit of the system of Fig. 1 together with a timing diagram;

Fig. 10 shows a remote control ultrasonic receiver circuit of the system of Fig. 1 together with a timing diagram;

Fig. 11 shows a remote control ultrasonic transmission circuit of the system of Fig. 1 together with a timing diagram;

Fig. 12 shows a carrier ultrasonic receiver circuit of the system of Fig. 1;

Fig. 13A shows in detail a decoder circuit of the receiver circuit of Fig. 12;

Fig. 13B shows a timing diagram for the decoder circuit of Fig. 13A;

Fig. 14 shows a carrier vicinity detector of the receiver circuit of Fig. 12;

Fig. 15 shows schematically a modified embodiment

of the carrier portion of the control system incorporating a digital speech synthesizer;

Fig. 16 illustrates an embodiment of the invention in which the control circuitry is implemented by a programmable logic array or by a microcontroller;

Fig. 17 is a flow diagram illustrating the mode of operation of the trolley mounted system; and

Fig. 18 is a flow diagram illustrating the mode of operation of the remote control unit.

There is shown in Figure 1 a golf trolley 1 comprising a body 2 having a load compartment 3, for supporting a golf bag, and a pair of rear drive wheels 4, 5 and a front jockey wheel 6. The body 2 houses an electric battery 7 for powering a drive motor 8 which is coupled via respective clutches to the left and right side drive wheels 4, 5. The drive wheels are provided with respective brake mechanisms such that the trolley can be steered by selectively disengaging the corresponding clutch and applying the corresponding brake mechanism at one side wheel and applying drive from the motor 8 to the wheel at the other side, at a moderate speed, so as to turn the trolley at a relatively low speed thereby minimizing the possibility of the trolley becoming unstable during the turn.

Figure 2 shows in detail the clutch and brake mechanism which is coupled to each of the drive wheels 4, 5 of the golf trolley. The mechanism is mounted within a housing through which the wheel axle and the

motor drive shaft pass. The clutch mechanism 9 comprises a tubular member 10 which is mounted onto the axle 11 of the wheel to enable the member 10 to slide telescopically into and out of engagement with a clutch plate 12 attached to the end of the motor drive shaft whilst remaining in driving connection with the axle (e.g. via a splined connection thereto). An annular bracket 13 is slideably mounted about a central region of the slidable tubular member 10 between a pair of helical springs 14,15.

A lever 16 is rotatably attached at one end to the annular bracket 13 and is additionally mounted for rotation about a central portion 16a such that rotation of the lever about said central portion causes the attached annular bracket 13 to move the slidable member 10 to the left or to the right depending upon the direction of rotation of a connecting rod 19. Rotation of the lever 16 is induced by means of a threaded shaft or worm gear 17 which is rotated by a small DC motor 18 operating at between 6 and 15 volts and an elongate connecting rod 19 which has a pair of through holes, the upper of which is threaded to engage the threaded shaft 17 and the lower of which slideably engages a rigidly mounted guide rail 20 parallel to the threaded shaft. The connecting rod 19 is provided at its upper end with a pin 21 which engages a slot 22 extending longitudinally along a proximal end portion 16b. Rotation of the threaded shaft 17 by the motor causes

the connecting rod 19 to move to the left or the right which in turn causes rotation of the clutch lever 16 about its central axis to engage or disengage the clutch.

The clutch and brake mechanism further comprises a rocker switch 23 positioned beneath the connecting rod 19 so that when the connecting rod passes over the rocker switch the switch is toggled from one position to the other. Figure 3 shows a schematic circuit diagram which illustrates the switching operation of the assembly of Figure 2. A pair of input terminals B and C are held permanently at voltages of 0V and +12V respectively whilst a third, control, input terminal A receives a voltage of +12V or 0V depending upon whether or not the wheel is required to rotate.

With the switching configuration shown in Figure 2, terminal 2 of the motor receives a voltage of 0V from terminal B. When a voltage of +12V is applied to terminal A the motor will rotate causing the clutch to move from its existing position to a second position, namely from the disengaged to the engaged position. At the end of its travel, the connecting rod passes over the rocker switch 23, (which corresponds to switch SW1 in Figure 3) disconnecting terminal 2 of the motor from terminal B and connecting it to terminal C. In this position, there exists no potential difference between terminals 1 and 2 of the motor and the motor will cease rotating.

In order to move the clutch from the engaged to the disengaged position, a voltage of 0V is applied to terminal A giving rise to a potential difference between motor terminals 1 and 2, which causes the motor to rotate in the reverse direction, disengaging the clutch. The position of the rocker switch is such that the switch is activated, stopping the motor, before a brake disc 24 contacts the inside surface of the clutch and brake mechanism housing.

If it is required to activate the brake, at the same time as a voltage of 0V is applied to terminal A (to disengage the clutch), an appropriate energising voltage is applied to a relay RL1 25 which over-rides the operation of switch SW1 causing the motor to continue rotating despite the operation of the rocker switch 23. Rotation continues until the brake disc 24 engages a brake pad 25 mounted on the inside of the housing whereupon the connecting rod 19 activates a further switch SW2 26 which de-energises the relay 25 allowing it to return to its normal position.

Figure 4 shows a steering control circuit which is used to provide the control signals A and D to the left and right clutch and brake mechanisms. These control signals are derived from a set of 8 control signals, left front, left turn, etc which are generated by a carrier receiver circuit the operation of which will be described hereinbelow. Figure 4 also shows a speed control circuit which controls the drive motor speed and

direction of rotation (i.e. forward or reverse).

With reference to Figures 5 and 6, mounted on the front of the trolley body 2 is an ultrasonic transmitter 26 which transmits a beam of ultrasonic radiation with an angle of divergence of approximately 90°. Positioned around the body 2 are several receivers 27 with various reception angles arranged so that the reception field of the carrier control system is maximised. Fig. 7 shows a remote control unit having a swivel head 28 on which are mounted three transmitters 29, each having a 60° wide transmission beam, and a receiver 30 having a 60° wide reception angle. The transmitters 29 are mounted so that their transmission beams overlap so as to increase the effective transmission range (e.g. from 10 to 25m). The main body 31 of the remote control unit has a plurality of control buttons 32 having various functions (as labelled).

Figure 8 illustrates in very general terms the functional interrelationship of the remote control circuitry and the carrier control circuitry. The carrier transmitter is arranged to transmit a stored identification code signal and at the same time deactivate the carrier receiver for 520mSec. Transmitted signals received by the remote control receiver are decoded and compared with a stored code. If the codes match, the remote control transmitter transmits a carrier control code after a 520mSec delay. The carrier control code will thus be received by the

carrier only after the carrier receiver has been reactivated. The carrier control circuitry also includes a vicinity detector the function of which will be described hereinbelow.

The circuity which provides overall control of the steering and motor control circuitry, and which operates the various ultrasonic receivers, in accordance with Figure 8 will now be described in detail with reference to Figures 9 to 14.

Fig. 9 shows the principal parts of the golf trolley carrier transmitter system for transmitting a stored identification signal in an interrogation mode periodically and incorporates part of the processing means for handling received response signals which is in turn connected to the main steering and motor control circuitry shown in Fig. 4.

Upon activation of the transmitter a 500 n Sec pulse is generated at the start of each cycle. It also starts the 40 Khz clock and the data out from the shift register is added with the 40 Khz signal through an AND gate to generate the data that will be transmitted to the remote control receiver.

When the 800 μ Sec pulse has finished, it triggers the 520 m Sec. delay that inhibits the receivers and starts the vicinity detector. Before the vicinity detector (see Figure 14) starts there is a 10 m Sec delay which allows the transmitted identification code to be clear of the trolley and at the same time resets

the counter. After the 10m Sec delay the output is "1" and the rise time of the pulse triggers the counter to the count of one. A 100 m Sec delay is then triggered. The output from the delay triggers a 12.5 μ Sec transmission pulse that is transmitted. A 7.2 m Sec delay is started during which the output of the delay is a "1" and that "1" goes to two NAND gates.

Fig. 10 shows the principal parts of the remote control unit receiver system for receiving carrier interrogation signals (transmitted by the circuit of Figure 9) and comparing an identification code contained therein with a stored identification code. In response to the recognition of a received identification code the circuit disables the remote control unit receiver and enables a response mode in the remote control unit transmitter after a predetermined delay of 520m Sec.

In more detail, when the system is in "auto" (i.e. reception) mode, the remote control unit receiver is open to receive interrogation signals. A received signal is amplified to give a TTL logic compatible signal. This amplified signal is then passed to an AND gate and, when the other two inputs to the AND gate are high, the output is high clearing a connected flip-flop and also enabling the an 800 μ Sec delay. A first of the inputs to the AND gate is provided by a receiver inhibit signal whilst a second is fed back from the output of the shift register. The flip-flop is reset every 100 μ Sec over the 800 μ Sec delay period in order

to clock the received identification code into a shift register coupled to the output of the flip-flop.

An eight bit comparator receives the data from the shift register and compares it with the identification code received from an identification code matrix. If the received identification code does not correspond to the stored code then one of the outputs X or Y is set low; if it does correspond, then both X and Y are set high. In the latter case, a 100 m Sec delay is activated. This delay inhibits the transfer of signals from the receiver and contributes to eliminating transmission bounce from external objects. After the 520 m Sec. delay, a pulse is generated which resets a 1.5 Sec delay and enables the transmitter identification timing (setting the 'ident timing enable' line high). If no pulse is received from the comparator during the 1.5 Sec delay, the 1.5 Sec delay is set and the identification signal and control signal are transmitted. The remote control unit continues to transmit in this way every 1.5 Sec.

In "manual" mode of the system the remote unit receiver is inhibited.

Fig. 11 shows the principal parts of the remote control unit transmitter system for sending a response signal after a predetermined delay following receipt at the remote unit of the trolley carrier identification code. Insofar as the response signal is simply used for timing purposes at the carrier receivers, its

particular form and content are not critical. Conveniently though it contains the identification code peculiar to the particular carrier - remote control unit combination, the carrier unit receiver means being provided with suitable comparator means for verifying the source of the response signal received before enabling further processing thereof including timing measurements etc. In addition the remote control unit transmitter system is adapted for transmitting various control signals corresponding to operation of the various keys and/or switch means provided on the remote control unit for user operation as shown in Figure 7.

With regard to the detailed format of the remote control unit transmissions, these conveniently may be of the following form.

The Identification Signal is an eight bit word. Bit 0 and bit 7 are always "1", bits 1 to 6 are switched in binary fashion making a selection of sixty four different identification codes.

The Control Signal is a seven bit word, the eighth bit is "0". Bit 0 and bit 6 are always "1", bit 5 is the mode code - when it is "1" it indicates auto mode and when it is "0" it indicates manual mode. Bits 1 to 4 can be used to operate up to fifteen independent commands from the key-board on the remote control unit.

Fig. 12 shows the principal parts of the golf trolley receiver system for monitoring the receipt of response signals at each of the receivers 12 on the

trolley body 2, for determining the relative direction of the remote control unit (with respect to the carrier) from the identity of the receiver and/or relative signal strengths at the receiver receiving response signals, and for generating suitable control signals in response thereto for the drive control system, e.g. to operate the right hand wheel drive to turn the trolley leftwards towards a remote control unit positioned to the left of the trolley.

Figure 13A shows in detail the receiver signal decoder circuit of Figure 12 (Figure 13B shows the signals present at various points in the decoder). When a receiver receives an ultrasonic signal, the output signal goes through a corresponding AND gate, all of the inputs of which will be "1". The rise time of the pulse triggers a corresponding flip flop and the "Q" output changes from a "1" to a "0" effectively blocking all of the receivers. The "Q bar" output of the flip flop changes from a "0" to a "1" triggering a timing sequence, setting the direction, and allowing the signal to go through a second AND gate. The signal continues through an OR gate (or OR gates) to a Pulse Error Detector (vicinity detector - Figure 14) which checks the signal: if only one pulse is received within the first 100 μ Sec of the signal then the receivers are reset and they will wait for the next signal; if two or more pulses are received within the first 100 μ Sec then the signal is allowed to continue. The signal sent to

the Pulse Error Detector also goes to an AND gate which triggers a flip flop which is reset every 100 μ Sec. The other input to the AND gate comes from a 75 μ Sec delay unit, which allows slippage of the signal, e.g. if the first pulse is missing from the piece of data then the first pulse from the second piece of data may interfere with the first piece of data.

The data is clocked into a parallel shift register and is clocked into latches and checked to see if it is correct (Figure 12). If it is faulty it would reset the receivers and wait for the next signal. However, if it is correct the range clock is stopped and the command signal is put into action. A 100 μ Sec delay is started which gives time for the trolley to put the commands into action.

Figure 14 shows in detail a vicinity detector portion of the circuit of Figure 12. If someone is in front (the vicinity detector receives a signal only from the front receiver) of the trolley a transmitted pulse will hit them and reflect back to the front receiver and to the vicinity detector where it will go through the gates to the two flip flops where it would toggle the flip flop once. Then after a 100 μ Sec delay a 500 n Sec pulse goes to the two NAND gates. If this time is within 7.2 m Sec of the transmitted vicinity pulse then a "0" will enable a pause through the NAND latched pair, making a "1" output for 'pause'. To reset the 'pause' the return vicinity pulse delay must be greater than 7.2

m Sec. A control signal will also reset the pause. The vicinity detector is active for four pulses and the counter counts the number of times it is activated. The 100 m Sec delay is the trigger to the counter and to itself using the change time of the AND gate as a delayed pulse. It is noted that the 'field of view' of the vicinity detector may be enlarged by connecting it to receive signals from two or more of the carrier mounted ultrasonic receivers.

On the trolley there is a manual control on the handle which operates in the same manner as that of the remote control unit (forward, reverse, left turn, right turn, start, stop, faster and slower).

Figure 15 shows a control system in which the circuitry of Figures 4 and 9 to 14 is implemented either using a programmable logic array or by suitably programming a microcontroller. The system also includes a digital speech module. The system is arranged so that if no signal is received, the trolley will stop and activate the digital speech module (which may also be used for other alarms and uses).

On manual, the remote control unit transmits the identification code and command code at 350 m Sec.

Figure 16 shows the circuitry of the remote control unit similarly implemented by a programmable logic array or by a programmed microcontroller.

Figures 17 and 18 illustrate by way of flow

diagrams the operation of the carrier and remote control systems respectively.

Example of Rangefinder Operation

Using ultrasonics transmitters transmitting at the speed of sound with a carrier frequency of 40 KHz, and at a 10 m separation between the trolley carrier and remote unit, the timing of the various operational steps is approximately as follows:

0 msecs: identification code sent by carrier;

30 msecs: identification code received at remote unit;

520 msec: delay at remote unit

550 msecs: remote unit response mode enabled and transmitter sends identification code;

580 msecs: response received at carrier receiver(s).

Thus the total time from sending of the interrogation signal until receipt of the response signal is approximately 580 msecs, 30 + 30 msecs in travel, and 520 msecs in built-in delay. Since the processing time element is relatively small it can be ignored for practical purposes. The known built-in delay time is eliminated by providing a similar built-in delay at the carrier for processing of the remote unit response signal leaving an effective travel time of 60 msecs which when multiplied by the signal velocity of approximately 332 m/sec and divided by two yields a separation measurement of 10 m, which is sufficiently accurate to allow a trolley to be maintained at a comfortable following distance of say 5 ft (1.5 m).

CLAIMS

1. An automatic motorized carrier control system for controlling the motor drive means of a carrier to maintain a generally predetermined separation distance between the carrier and an operator, the system comprising:

ultrasonic transmitter and receiver means and interrogation control means for mounting on the carrier, the interrogation control means being arranged to periodically enable an interrogation mode in which the carrier transmitter is activated to transmit an ultrasonic identification code and the carrier receiver is disabled for a predetermined period of time;

a remote control unit arranged to be carried by the operator and comprising ultrasonic transmitter and receiver means and identification code recognition means, the identification code recognition means being arranged to compare a received identification code with a stored code and, if the received code and the stored code match, to disable the remote control ultrasonic receiver and to transmit an ultrasonic carrier control signal after a predetermined delay for reception by the carrier ultrasonic receiver means in a time period following the interrogation mode;

timing control means coupled to the carrier ultrasonic transmitter and receiver means and the interrogation control means for calculating the time delay between transmission of the identification code

and reception of the control signal and for calculating therefrom the separation distance of the carrier and the operators; and

carrier drive control means, coupled to the timing control means, for controlling the motor drive means to maintain said generally predetermined separation distance.

2. A system according to claim 1, wherein the carrier receiver and interrogation control means are arranged to determine the direction from which a carrier control signal is received and to cause the carrier to move substantially in said direction.

3. A system according to claim 2 and comprising a plurality of carrier receivers arranged to be spaced about the periphery of the carrier, wherein the interrogation control means is arranged to determine the direction from which a control signal is received by determining at which receiver a signal is first received or by comparing the relative magnitudes of received signals.

4. A system according to any one of the preceding claims, wherein the interrogation control means is arranged to disable the carrier receiver means for a period of at least 7.2 msec following the transmission of an ultrasonic identification code.

5. A system according to any one of the preceding claims, wherein the identification code recognition means of the remote control unit is arranged to disable

the remote ultrasonic receiver means for a period of at least 100 μ s following the reception of a code matching the stored code.

6. A system according to any one of the preceding claims, wherein said predetermined delay after which a carrier control signal is to be transmitted is at least 7.2 msec.

7. A system according to any one of the preceding claims, wherein said predetermined period of time and said predetermined delay are substantially of the same length.

8. A system according to any one of the preceding claims and including a vicinity detector arranged to detect objects within a given distance of a carrier and substantially in the path in which the carrier is currently moving, and means for temporarily stopping the carrier in the event that any such object is detected.

9. A system according to claim 8, wherein the vicinity detector is coupled to the carrier receiver means and is arranged to analyze the output thereof to identify ultrasonic signals generated by the carrier transmitter means and which have been reflected by objects.

10. A system according to claim 9, wherein the carrier transmitter means is arranged to transmit alternately an identification code and a vicinity code, the duration of the vicinity code being greater than that of the identification code, wherein the vicinity detector is arranged to discriminate reflected vicinity codes from

other received signals by analysing received signals.

11. An automatic motorized carrier control system comprising range-finder means for monitoring the separation of the carrier from a remote unit carried by the user of that carrier and carrier drive control means coupled to said range-finder means and formed and arranged for enabling and disabling drive means of the motorized carrier above and below a predetermined separation, the range-finder means comprising a two-way ultrasonic communications system with carrier transmitter and receiver means and remote unit transmitter and receiver means and the carrier transmitter means comprising an interrogation control means for periodically enabling an interrogation mode in which the carrier transmitter sends an identification code corresponding to that of the associated remote unit, and the carrier receiver is disabled for a predetermined period of time, the remote unit receiver means comprising identification code recognition means formed and arranged for comparing the identification code received from the carrier with a stored predetermined identification code, and upon recognition of a match confirming that said carrier is one required to follow said remote unit, disabling the remote unit receiver means and enabling a response mode wherein a carrier control signal is transmitted after a predetermined time delay, said interrogation control means being formed and arranged so that the

interrogation mode is disabled during a period allowing reception of transmissions from the remote unit in its response mode, said carrier receiver means being provided with timing means formed and arranged for measuring the time delay in receiving the carrier control signal due to the remote unit separation from the carrier to provide an indication of said separation, whereby in use, the carrier may follow its associated remote unit at a generally predetermined distance.

12. An automatic carrier control system substantially as hereinbefore described with reference to Fig. 1 and Figs 5 to 18.

13. A clutch mechanism for coupling a motor drive shaft to a shaft to be driven by causing relative linear movement between the two shafts, the mechanism comprising an electric motor, a threaded shaft coupled to the motor for rotation thereby and extending in a direction substantially parallel to the direction of said relative linear movement, and link means threadably engaging the threaded shaft and coupled to one of said shafts, wherein rotation of the shaft causes relative movement of the link means which in turn causes said relative linear movement between the two shafts.

14. A clutch mechanism for coupling a motor drive shaft to a shaft to be driven, and operated by axial displacement of first and second clutch portions, wherein there is provided an electric motor, drivingly coupled to a moveable said clutch portion via coupling

means comprising a worm gear and nut means in which the worm gear means is formed and arranged so as to be driven by said electric motor and said nut means is, directly or indirectly, connected to said moveable clutch portion for axial displacement of said moveable clutch portion by means of operation of said worm gear means.

15. A mechanism according to claim 13 or 14, wherein the link means comprises a connecting rod which is slideably mounted on a fixed guide rail and which threadably engages the threaded shaft and a lever mounted for rotation about a central region and coupled, at a first end region, to one of the shafts and at a second end region to the connecting rod.

16. A mechanism according to any one of claims 13 to 15 and comprising switch means arranged to be activated at ends of the link means travel in order to switch off the power supply to the motor when the clutch is completely engaged or disengaged.

17. A mechanism according to any one of claims 13 to 16 and comprising brake means which is engaged when the link means reaches an extreme end of its travel.

18. A clutch mechanism substantially as hereinbefore described with reference to Figures 1 to 3 of the accompanying drawings.

19. A golf trolley comprising a system according to any one of claims 1 to 12 and/or a mechanism according to any one of claims 12 to 16.

20. A golf trolley substantially as hereinbefore described with reference to the accompanying drawings.

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10 January 1995

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) WPI

Documents considered relevant following a search in respect of Claims :-
1 to 12

Categories of documents

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Category	Identity of document and relevant passages		Relevant to claim(s)
A	US 4844493	(D C KRAMER)	
A	US 3856104	(SHUNJIRO OHBA)	

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